Project Report: Biogeochemical cycling and resources on Mars

Project Investigator:	***Bruce Jakosky***

Project Progress

We are exploring the geochemical energy that can support metabolism via chemical weathering at low temperatures on Mars. Such low–temperature environments may be widespread, based on recent discoveries and analyses pertaining to Martian gullies, sub–freezing liquid water, crater lakes, and depositional environments. Our results will be used to determine which types of geological environments are most suitable for supporting Martian organisms, and what the availability of energy as a resource is. To answer these questions, we have been using three different geochemical reaction modeling programs (EQ3/6, PHREEQC, and Geochemist's Workbench). All three programs have been used to simulate the mixing of water with various host rock compositions based on Martian meteorites, to determine geochemical weathering pathways, and to estimate available energy that can support metabolism. Currently, we are using Geochemist's Workbench to determine various weathering products and estimate available energy based on Gibb's free energy, and have looked at three different reactions (the weathering of fayalite, ferrosillite, and magnetite) as an initial approach to the problem. For these three reactions, we have varied the temperature (0–25 degrees C), and looked at a range of H_2 fugacities to determine which temperature and fugacity will produce the most energy. This allows us to determine the conditions that have optimal geochemical energy available to organisms.

In the near future, we will develop a reaction matrix that will include a wider range of possible reactants and products for Mars based on terrestrial analogs and what is known about Martian mineralogy.

Highlights

- We are exploring the energy available to support metabolism of potential Martian organisms in aqueous environments at ambient conditions on Mars. Such environments might be widespread on Mars, given recent discoveries and analyses (including the Mars rover discovery of depositional environments).
- We anticipate obtaining results shortly that will be applicable to planning of future Mars exploration missions, determination of Martian

habitability, and the search for life on Mars.

Roadmap Objectives

- ***Objective No. 2.1:*** Mars exploration

Mission Involvement

Mission Class*	***Mission Name (for class 1 or 2) OR Concept (for class 3)***	***Type of Involvement*** **
1	Mars Global Surveyor	Science Team Member
1	Mars Odyssey	Science Team Member
2	Mars Science Laboratory	Planning Support
2	Astrobiology Field Laboratory	Planning Support

* Mission Class: Select 1 of 3 Mission Class types below to classify your project:
1. Now flying OR Funded & in development (e.g., Mars Odyssey, MER 2003, Kepler)
2. Named mission under study / in development, but not yet funded (e.g., TPF, Mars Lander 2009)
3. Long–lead future mission / societal issues (e.g., far–future Mars or Europa, biomarkers, life definition)

** Type of Involvement = Role / Relationship with Mission
Specify one (or more) of the following: PI, Co–I, Science Team member, planning support, data analysis, background research, instrument/payload development, research or analysis techniques, other (specify).

Jakosky is involved in oversight of the study group that is defining the AFL mission.